able here. More space is occupied by the London School Board, whose lending libraries for schools and reference libraries for pupil teachers are well selected. The geographical teaching cannot, of course, be compared with that on the Continent, though some of the district maps are good. Fair provision is made for teaching science to pupil teachers, but there is a lamentable deficiency in the apparatus for this and for the whole system of object-lessons, when the needs of the scholars themselves are considered. The School Boards of Edinburgh and Glasgow show some excellent models, photographs, and plans of school buildings of the newest type, and some remarkable specimens of drawing. The Wesleyan Education Committee show some excellent results of the scientific and handicraft training of boys, and some very simple yet remarkably effective appliances for elementary geographical instruction.

Although these collective displays by public bodies are the most interesting feature of this portion of the Exhibition, there is much that will repay examination in the various objects shown by many single exhibitors of the great variety of school desks and furniture; some of the desks of G. M. Hammer, G. E. Hawes, and H. Simon and Co., deserve more than a passing notice, as do also the revolving partitions of Hodkinson and Clarke. Among maps and charts the collection of Mr. E. Stanford stands out prominently, and is specially noticeable for the five series of physical and orographical maps, some of which in frames are on continuous sheets and rollers. Mr. Bacon's maps are singularly clear and good for school use, and his picture-lessons in geography are a step in the right direction. The apparatus for teaching music, exhibited by J. Curwen and Sons, is perhaps not approached by any similar exhibit. The science charts and diagrams produced by M. Emile Deyrolle are of an extremely high degree of excellence, and deserve to be made widely known. The educational publications of such firms as Messrs. Cassell and Co., Messrs. Gill and Sons, the Messrs. Johnston, Messrs. Griffith and Farran, Messrs. Bemrose and Sons, and Messrs. William Collins, Sons, and Co., who are all well represented, are too well known to need more than a reference.

In a second article we hope to deal in a similar way with the exhibits of apparatus and results of scientific and technical teaching carried to a higher degree than in mere primary schools, and also, briefly and by way of introduction, with that range of subjects which may be shortly described as comprising the technical education of children and girls. It may perhaps be permitted to the writer to say, as the result of a very close examination (extending over more than a week continuously) of the exhibits relating to primary education in various countries, that one important lesson to be learnt from the comparison of Continental methods with our own is the great advantage afforded by the objective system of teaching, and by the adoption of that systematic order and method in all subjects of instruction, literary or otherwise, to which the name scientific, in the highest and best sense of the term, is applicable.

WM. LANT CARPENTER

WORK-MEASURING MACHINES[1]

UNDER this title a little *brochure* has recently appeared from the pen of the Rev. F. J. Smith, B.A., of Taunton, in which work-measuring dynamometers, or *ergometers*, as the author terms them, of various forms are described. Amongst these machines there are many devised by the author himself, and some of these are of considerable interest and much originality. The transmission ergometers of the type originally invented by General Morin deserve notice in particular. The following is the general principle involved in transmission ergometers:—

Let it be supposed that a belt passes over from the driving wheel of a prime-mover such as a steam-engine to the pulley of a dynamo which is being driven. One half of the belt is subjected to a strong pull, the other is relatively slack. Then if we could introduce spring balances into the two parts of the belt, and if we could read the difference of the tensions T and T', and if we multiplied this $\text{T} - \text{T}'$, expressed in pounds, by the velocity of the belt in feet per second, we should then have the "foot-pounds per second" spent in driving the dynamo. From this we can calculate the horse-power by dividing it by 550, since 550 foot-pounds per second is one horse-power. This we may write algebraically:—

$$\text{H.P.} = \frac{(\text{T} - \text{T}')}{550} v;$$

where v denotes the velocity of the belt in feet per second.

Now since such an arrangement as this cannot be easily carried out, the usual method is to place between the engine and the dynamo some instrument capable of showing the tension of the belt in pounds, and the velocity of the belt, and in certain cases these instruments can even give a continuous record of the work done. The ergometer devised by Mr. Smith is an admirable instance of such a combination, and it undoubtedly possesses points of superiority over all transmission dynamometers hitherto invented. A view of the machine (see figure) shows how the ergometer is arranged. The central shaft, of Whitworth steel, which is tubular at each end and link-shaped between, carries two pulleys. One is keyed to the shaft and carries two bevel-wheels, these engage with another bevel-wheel which forms part of the second pulley, which is loose on the shaft.

To each of the two bevel-wheels, as shown in the diagram, there is fitted a cylindrical drum, on these either gut or steel tape is coiled over three-fourths of their faces, and the gut or tape is attached to a cross-head. The latter is in turn attached to a cylindrical steel spring placed within the link, and from the cross-head a rod of steel, passing through one end of the link, actuates the pointer of a dial, whereby the pull on the spring attached to the end of the link is shown. This instrument resembles therefore the earlier dynamometer of Morin in having two pulleys; the angular advance of one of them being regulated by a spring. But in Morin's form the spring was simply an extended piece of steel. In the more recent modification by Profs. Ayrton and Perry, coiled steel springs are also used; but in that instrument the springs are liable to fly out by centrifugal force, and the arrangement for observing the angular advance is an optical one, requiring an observation of a silvered bead by a reading-telescope. In Mr. Smith's ergometer there is no such tendency of the spring to fly, and the tension is read direct on a dial. The speed indicator is shown just below. If a continuous record of work is required, the steel rod is either attached to a recording drum or to an integrating apparatus.

The instrument having been placed between a prime-mover and a machine to be tested, the belt from the prime-mover drives the loose pulley, and another belt from the fixed pulley drives the machine to be tested. The tension on the driving side of the belt causes the spring to be extended by means of the bevel-wheels, and difference of the tensions is indicated by the pointer of the dial. The instrument is calibrated by hanging known weights from strong thin cords or catgut strings passing round the pulleys, and marking the dial in accordance with the weights.

The springs used by Mr. Smith are made by Messrs. Salter and Co., they are of four sizes, capable of being extended 2 inches by 50, 100, 150, and 200 lbs. respectively. They have been put to severe tests, but have come

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[1] "Work-Measuring Machines." By Frederick J. Smith, B.A. 32 pp. 12mo. (London: E. and F. N. Spon, 1884.)

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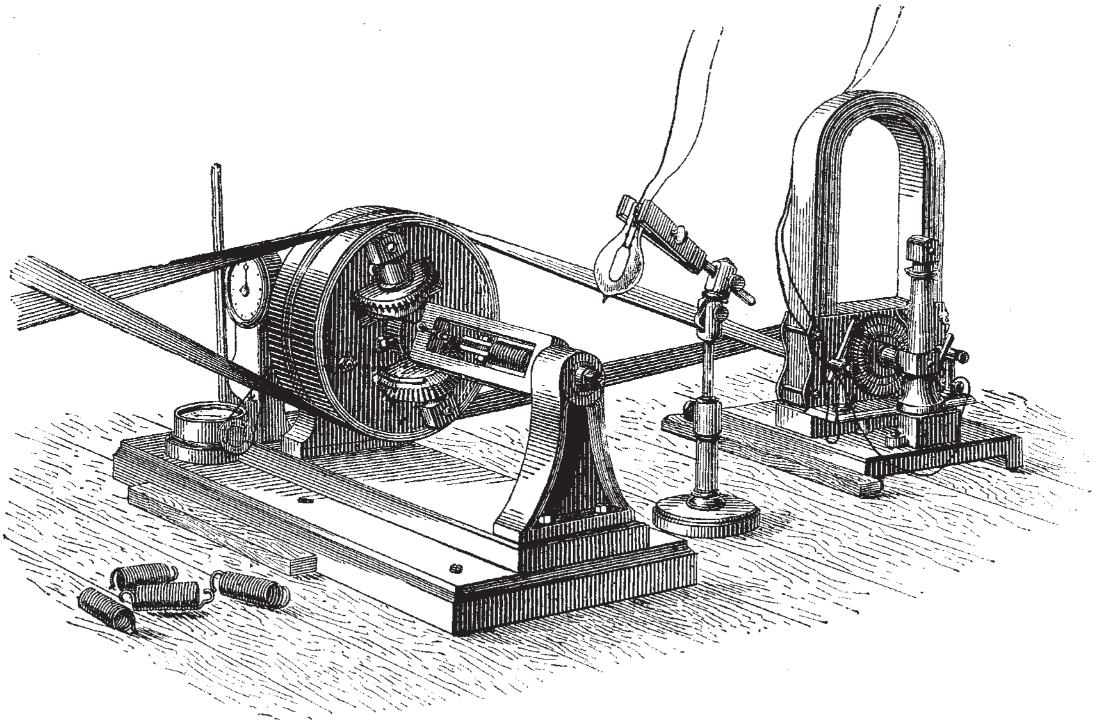
out of them quite unaltered. However, so as to leave no doubt as to the accuracy of the readings of the ergometer, the instrument is finally calibrated by another method, which is new; it is as follows:—

Let a prime-mover (a water-wheel appears to be the most steady) drive the transmission ergometer, and let the ergometer drive a pulley on a shaft embraced by a suitable friction ergometer, such as a Prony brake or an Appold's brake, and let the work done against friction be calculated. This should agree with the results of the transmission machine. If it does, we may conclude that it has been correctly calibrated. The advantage of this method is that the transmission machine is tested while running in its usual condition. When testing a dynamo care should be taken that the speed indicator be well attached to the shaft the velocity of which it is measuring. A piece of coiled spring, such as is used in a dentist's lathe, answers well to connect it to the machine.

The leading feature of this instrument is the position of the spring in it. The axis of the spring and of the shaft coincide; the result of this is that it is hardly at all affected by centrifugal force. When springs of slight pull are used and the ergometer is driven at a great velocity, the deformation is considerable, and would introduce considerable error into the result.


Smith's Transmission Ergometer.

The deformation of the spring has been fully appreciated by Schuckert, and therefore he has placed the spiral springs of his ergometer in cylindrical cases.

When the spring is placed with its axis coincidental with that of the machine, no such error can be introduced, and the friction of a spring against a case is avoided.

When a continuous record of work is required, a cylinder, not shown in the figure, is placed at the dial end of the instrument, and is driven at a speed proportional to the speed of driving. It carries a band of paper which receives a continuous trace from three self-feeding ink-pens: one pen is attached to the lever which is moved by the extension of the spring, and it writes ordinates directly proportional to the amount of extension of the spring at any instant; the second pen, attached to the lever of an electro-magnet magnetised by a current controlled by a seconds pendulum, describes a V-shaped mark at each second; the third pen traces a datum line to which the ordinates are perpendicular. The area traced out is of course the product of the two variables, and is proportional to the total work transmitted. The recording drum may be made to revolve at any convenient ratio to the revolutions of the belt wheels. We are indebted to Mr. Smith for the loan of the figure which illustrates this notice.

NOTES

We are authorised to state that there is no truth in the rumour that Mr. Oscar Dickson intends to equip an Antarctic Expedition under the command of Baron Nordenskjöld.

The Rev. Dr. Salmon, Regius Professor of Divinity in Trinity College, Dublin, has been selected by the Institute of France to fill its vacant foreign membership.

According to the constant practice of the French Academy of Sciences, the seat occupied by M. Jamin in the Section of Physics is considered as vacant, and a new election will take place.

A meeting was recently held in the Hall of the Institution of Civil Engineers, Great George Street, Westminster, to consider what steps should be taken to raise an Engineers' Memorial to the late Sir William Siemens. Sir Joseph Bazalgette, as President of the Institution, was asked to preside. The Chairman pointed out that a general desire had been expressed among engineers that some memorial should be raised as a recognition of the great merits and important services rendered to engineering by Sir William Siemens. It has been ascertained that it would be agreeable to the authorities of Westminster Abbey that a window should be placed in that building to the memory of the deceased. Possibly the cost of such a window might amount to

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